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(71) Applicant: CENTRO ACCIAI S.p.A.
Strada Statale 98, Km 78,900
I-70032 Bitonto (IT)

(72) Inventor: Pellecchia, Antonio
Viale Italia, 15/11
I-70027 Palo Del Colle (IT)

(74) Representative: Boggio, Luigi et al
STUDIO TORTA Società Semplice Via Viotti, 9
I-10121 Torino (IT)

(54) A semi-rigid road barrier providing controlled dissipation of impact energy and attitude correction.

(57) On each upright (13) is pivoted a pair of energy-dissipating plates (32) connected to a shaped attachment element (26) of the rail (10) by two vertically-spaced couplings (38, 29; 38, 30). These include a partition (38) adapted to be sheared following an impact so as to dissipate part of the energy. The plates (32) are pivoted on a pin (43) on a strengthened portion (19) of the upright (13) and are provided with curved slots (44) engaged with another pin (47) on this portion so as to allow the plates (32) and the rail (10) to rotate should the upright (13) be bent outwards. The pins (43, 47) can slide vertically upwards in corresponding slots (21, 24) formed in the upright (13). The uprights (13) are also interconnected by a shaped elongate wheel-impact element (48) and by a rear flat rib (51) which acts as a tie bar in the case of an impact.

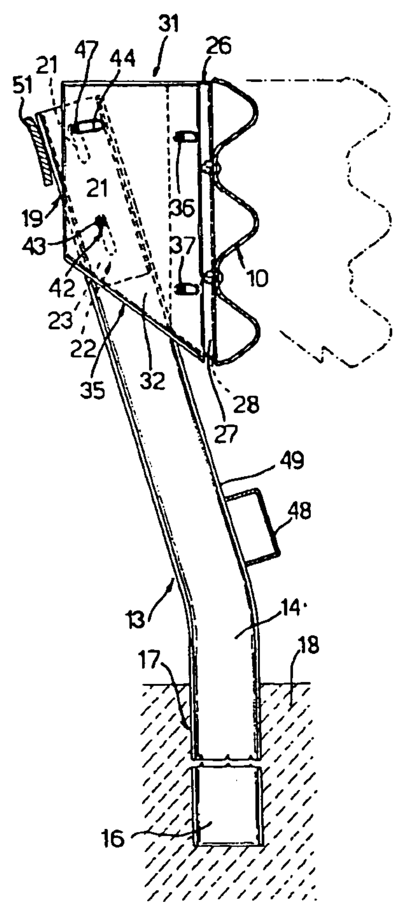

Fig.6

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Jouve, 18, rue Saint-Denis, 75001 PARIS

The present invention relates to modifications to conventional metal road barriers so as substantially to alter their behaviour when hit and optimise potential absorption of energy.

When hit, prior art road barriers are generally deformed in an unpredictable and uncontrolled way, often involving transverse deformation of the elongate member or rail with further outward rotation of the upper portion which virtually becomes an inclined plane which the impacting vehicle can easily ride over.

The invention consists essentially in improving and ensuring the absorption and also the dissipation of the impact energy of a swerving vehicle. To this end, the barrier of the invention includes a mechanical energy-absorbing connecting and/or coupling element for rendering any deformation of parts connected thereby (rail and support posts or uprights) gradual and controllable when these parts are subject to dynamic forces of whatever size generating compression, traction, bending, torsion and/or cutting.

The structural characteristics of the road barrier of the invention, and the advantages obtained by it, are clear from the following description which starts with an analysis of the mechanism by which the individual component elements are deformed and concludes by explaining the overall operation of the barrier.

The longitudinal connecting member of a metal road barrier of the "triple crest" type is connected to the support upright not directly but by means of an articulated system consisting of a spacer which includes a pair of energy-dissipating plates, fixed at their front ends to the rail by a riveted profiled section and pivoted at their rear ends on a strengthened portion of the support upright.

The dissipating plates are provided with curved slots which permit the rotation both of the plates themselves and of the rail if the upright is bent outwards. The uprights, for their part, are connected longitudinally by a front wheel-impact rib and an elongate rear rib having the specific role of increasing the cable effect in the final restraint of the colliding vehicle.

When hit, the profiled section connecting the plates and the rail moves parallel to itself, absorbing and dissipating a first portion of the energy from the impact. The subsequent deformation of the upright, as a result of bending outwards, assisted by the cable effect of the front and rear ribs, causes the system made up of the two plates side-by-side to rotate about its own fulcrum, in the vertical plane, thanks to the presence of guide-slots, with the final result being that the triple-crest rail remains vertical.

Further characteristics of the invention under consideration, as well as its advantages, will become clear from the following description of a few preferred embodiments, illustrated by way of non-limitative example in the appended drawings, in which:

Figure 1 is a partial front view of a road safety barrier according to the invention;
Figure 2 is a plan view of the barrier of Figure 1;
Figure 3 is an enlarged vertical cross-section taken on the line III-III of Figure 1;
Figure 4 is a further enlarged horizontal cross-section taken on the line IV-IV of Figure 3;
Figure 5 is an exploded perspective view of a detail of Figure 3;
Figure 6 is a cross-section of Figure 3 in a position resulting from an impact;
Figure 7 is a plan view of a double directional-separator barrier with independent uprights;
Figure 8 is a cross-section taken on the line VIII-VIII of Figure 7;
Figure 9 is a plan view of a double directional-separator barrier with common uprights;
Figure 10 is a cross-section taken on the line X-X of Figure 9; and
Figure 11 shows an enlarged view of a detail of Figure 10.

With reference to Figure 1, a semi-rigid road safety barrier, commonly known as a guard rail, suitable for installing along the outside edge of a carriageway of a road is generally indicated 9. The barrier 9 includes the usual rail 10 made up of a series of lengths 11 of a strong corrugated metal strip (see also Figure 3) for example with three crests. The various lengths 11 are connected together by superimposing two end portions 12 and rigidly fixing them with bolts.

The rail 10 is supported by a series of posts or uprights, generally indicated 13, spaced by a predetermined distance. Each upright 13 is formed by a profiled metal section 14 (Figures 3 and 4) having a C-shaped section and positioned with the base wall or web 16 perpendicular to the road axis.

Each upright 13 has a lower portion 17 fixed in any conventional manner to a suitable foundation or to a kerb 18 of the road carriageway, and an upper portion 19 provided with two vertical-axis slots 21. The portion 19 is strengthened with a length of another C-shaped section 22 the base wall 23 of which is provided with two slots 24 (Figure 5) corresponding to the slots 21. The dimensions and position of the section 22 are such that it forms a rectangular box structure with the section 14.

The rail 10 is provided in turn with a series of attachment elements or members, each made up of a C-shaped section or element 26 and each having two flanges 27 and a base wall or web 28. Each flange 27 of the element 26 has two holes 29, 30 vertically spaced by a predetermined distance.

A spacer element or double-pivot spacer, generally indicated 31, is positioned between the upper portion 19 of each profiled section 14 constituting the upright 13 and the corresponding attachment element 26. In particular, the spacer 31 is formed by a pair of plates 32 of right-angled trapezium shape, the

longer base of which is substantially the same length as that of the element 26 and the inclined edge 35 of which is at the bottom.

The lower edge of the element 26 has the same inclination as the side 35 of the plate 32. Both the top and bottom edges of the element 26 are stiffened by ribs which differ from each other, possibly with appropriately positioned notches provided to enable preferred distortion in predetermined planes. The characteristic function of the rail-spacer attachment elements 26 is to absorb and therefore dissipate a first portion of impact energy thanks to their ability to move parallel to themselves up to a maximum predetermined distance.

The two plates 32 are adapted for connection to the two flanges 27 of the element 26. To this end, each plate 32 is provided with a pair of holes 33, 34 positioned in correspondence with the two holes 29, 30 in the corresponding flange 27 of the element 26. A corresponding pair of bolts with nuts 36, 37 (Figures 3 and 4) engages the pair of holes 33, 34 respectively in the two plates 32 and the pair of holes 29, 30 respectively in the two flanges 27, fixing the plates 32 to the element 26.

Adjacent each hole 33, 34 (Figure 5) is a corresponding hole 39, 41 respectively, separated from the former by a partition 38 which can be easily sheared. Both the holes 33, 34 and the holes 39, 41 are semicircular and positioned so that each partition 38 has a constant section, thereby permitting controlled shearing.

The connection between the attachment element 26 and the plates 32 constitutes a dissipator of the energy from an impact against the portion of rail 10 adjacent this element 26. In fact, when such an impact exceeds a certain magnitude, the bolts 36, 37 break the partitions 38 and engage the holes 39, 41, causing the rail portion 10 to move towards the plates 32.

In Figures 3 and 5, the holes 39, 41 are equal and symmetrical relative to the holes 33, 34. However they may be differently shaped and positioned so as to vary the dissipation of energy, and may have an elongate shape so as to vary the relative movement between the element 26 and the plates 32 after the partitions 38 have been sheared.

Each plate 32 is also provided with a hole 42 through which the spacer 31 is pivoted on the upright 13 so as to project therefrom. In particular, the hole 42 is substantially equidistant from the holes 33 and 34. A bolt with nut 43 is inserted through the hole 42 in the two plates 32 into the lower slot 24 in the strengthening section 22 and into the corresponding slot 21 in the profiled section 14.

In addition, each plate 32 is provided with a curved slot 44 positioned slightly above the hole 33. The slot 44 is in the shape of an arc of a circle concentric with the hole 42, with a radius equal to the distance between the two slots in the profiled sections 14 and 22. This circular arc has one end 46 positioned on a line parallel to the shorter base of the plate 32 and extends from here towards this shorter base, thereby permitting the plates 32 to rotate forwards relative to the upright 13.

Another bolt with nut 47 is inserted through the curved slot 44 in the two plates 32, the upper slot 24 in the strengthening section 22 and the corresponding vertical slot 21 in the section 14. The plates 32 are positioned so that the ends 46 of the slots 44 abut the bolts 47 so that the rail 10 is positioned substantially vertically. The nuts of the bolts 47 are tightened so that the rail 10 is normally held in this vertical orientation despite its overhanging weight relative to the fulcrum of the plates 32.

In addition, the uprights 13 (Figures 3 and 4) are connected together by a front rib formed by a shaped wheel-impact strip 48. This has a C-shaped section and is fixed by any conventional means to a flange 49 of the profiled section 14 at an appropriate height for the purpose for which it is provided. Finally, the uprights 13 are connected together at the rear by a rear rib, formed by a flat or slightly curved section 51 which is bolted to the other flange 52 of the profiled section 14.

If there is an impact on the rail 10, the section 51 acts as a tie bar causing the adjacent uprights 13 to cooperate.

If a vehicle impacts on the rail 10 with some force, first the bolts 36, 37 shear the partitions 38 between the holes 33 and 39 and between the holes 34 and 41 of the plates 32, thereby dissipating a first portion of the impact energy, as previously stated. Depending on the position of the impact, either the partition 38 between the upper holes 33, 39 alone may be sheared or that between the lower holes 34, 41 alone.

Thereafter, once impact has occurred and after a first phase of energy absorption thanks to shearing of the said partitions 38 separating the horizontal holes 33, 39 and 34, 41 of the plates 32 by the bolts 36, 37 which connect the said plates 32 to the front attachment elements 26, the residual impact energy causes the profiled section 14 constituting the upright 13 to bend outwards with plastic deformation at its base joint. In other words, this residual energy causes the profiled section 14 to bend towards the outside of the carriageway, either by bending near its point of fixing, as shown in Figure 6, or by yielding of the foundation 18. As a result of this inclination, the thrust centre of the incident force is beneath the fulcrum constituted by the bolt 43 on which the two plates 32 forming the spacer 31 are pivoted so that the impact energy easily overcomes the friction between the bolt 47 and the plates 32 and makes the bolt slide along the curved slots 44 in the plates 32. This enables the plates 32 to rotate easily in the clockwise sense about the bolt 43 from the position indicated by a chain line. The rail 10 thereby maintains its substantially vertical

orientation, avoiding following the bending of the upright 13.

Should the rotation of the plates 32 prove insufficient, this rotation is increased by the greater deformability of the lower edge of the plate 32 compared to the upper edge, thanks to the inclined side 35 being longer and less rigid. As the upright 13 continues to be deformed, the rail 10 is able to maintain its original height thanks to the bolts 43 and 47 sliding along the slots 21 in the profiled section 14 and along the slots 24 in the section 22 as a result of the thrust transmitted to the rail 10 during impact, in such a way that the entire spacer 31 moves upwards into the position indicated by an unbroken line in Figure 6.

Therefore, the rail 10 follows the angular movement of the plates 32, to which it is closely connected, and assumes a vertical configuration relative to the ground which is substantially unaltered from that before the impact, freeing itself from the bending of the upright 13 and avoiding the creation of a dangerous plane inclined towards the outside of the carriageway.

In particular, as a result of this attitude correction, at the end of the impact the rail has moved from its original position, thereby preserving both its vertical attitude and its height and reducing the risk of a vehicle riding over it. The presence of the strengthening section 22 and the pair of dissipating plates 32 enables the load on the upright 13 at the moment of impact to be distributed symmetrically, thereby reducing the twisting effects of this impact.

The movement of the rail 10 also has a cable effect which involves the portions of rail 10 supported by adjacent uprights 13 in the energy absorption. The bending of the rail 10 parallel to itself and the action of the rib 51 which acts as a tie bar greatly increase the cable effect of the barrier 9 by involving a greater number of uprights 13 in the energy absorption.

It is therefore clear that between the spacer 31 and the upright 13 are provided means 44, 47 which enable the spacer 31 to rotate to a certain extent relative to the upright 13 in such a way that, after the upright 13 has been bent towards the outside of the carriageway, the spacer 31 maintains the rail 10 in a substantially vertical orientation. It is further clear that the impact energy is absorbed partly by the shearing of the connections 36, 38 and 37, 38, partly by the rotation and translational movement of the spacer 31 and partly by the bending of the upright 13 and the cable effect of the ribs 48 and 51 so that the energy is dissipated in a controlled manner.

The presence of the strengthening section 22 and the pair of plates 32 of the spacer 31 inhibits, though not completely, any twisting in the preferential planes in which they lie. In addition, the bending of the upright 13, and therefore the movement of the rail 10, always involves adjacent spans which thereby actively contribute to the absorption and resulting dissipation of residual impact energy. This active involvement is noticeably increased by the presence of the upper rib 51 mounted on the rear flange 52 of the post 13, which rib 51, when subject to traction, calls into action a greater number of uprights 13.

When the barrier 9 is to be used as a directional separator, it may be doubled as shown in Figures 7 and 8. Each of the two paired barriers 9 will therefore be formed by a series of uprights 13, each connected to the rail 10 by means of a spacer 31. In addition the uprights 13 will be connected together by a shaped wheel-impact strip 48 and a tie-bar rib 51. Finally, in the double barrier 9, the uprights 13 and the portions 12 joining the lengths 11 of the rail 10 will be appropriately staggered longitudinally.

In the embodiment of Figures 9 and 10, the directional-separator barrier 9 is formed by a single series of uprights 13, connected together by two opposing wheel-impact strips 48. The two rails 10 are connected in turn to the profiled section 14 and to the respective strengthening section 22 of the same upright 13 by a single energy-dissipating spacer 31'.

The spacer member 31' is formed by a single pair of plates 32' having swallow-tailed lower edges 53. The plates 32' are fixed to each of the two attachment elements 26 by two bolts operable to shear the partitions 38 (Figure 11) similar to those of Figures 1-5. On the other hand, the plates 32' are fixed to the upright 13 on a common fulcrum 43' and are provided with a single curved slot 44' symmetrical about the vertical centre line. The two slots 44' thus allow the spacer member 31' to rotate in either sense.

The advantages of the barrier according to the invention over prior art barriers are clear from the above description. In fact, the rotation of the plates 32, 32' relative to the upright 13 is greatly facilitated by not being linked to the breaking of any coupling. In addition, the presence of two vertically spaced couplings for dissipating impact energy ensures that dissipation is effective whatever the point of impact on the rail.

In particular, the double-face spacer 31 connecting the corrugated strip 10 and the post 13 is operable:

a) to absorb the first impact shock with spectacular distortion without bending the post 13;

b) once the post has started to bend, to provide the maximum contact surface between the corrugated strip 10 and the impacting vehicle;

c) to provide additional energy absorption by means of twisting of the upright 13;

d) spectacularly to increase the cable effect of the final restraint of the impacting vehicle, thereby further contributing to increasing the total impact energy dissipated.

The invention therefore gives the barrier designer greater scope by increasing the design variables for the absorption of impact energy from the usual two

(corrugated strip and posts) by the addition of a further four design variables deriving from the said points a), b), c) and d). The invention therefore means that, during design of the barrier, both the maximum quantity of energy absorbable and its variation from the moment of impact to the stopping of the vehicle may be predetermined.

From the above, it is clear that the combined and gradual action of individual elements constituting the complete system provides the possibility of directly controlling the process of dissipating impact energy. The road barrier according to the invention also provides undeniable advantages over prior art barriers because the presence of various impact energy-dissipating couplings ensures overall effectiveness whatever the point of impact and its intensity.

Naturally, various alterations and modifications may be made to the barrier as described without departing from the scope of the claims. For example, a single, appropriately strengthened plate 32 may be used for the spacer 31, 31'. This plate 32 may also have a different shape, for example a parallelogram. In its turn, the attachment element 26 which carries the dissipating means 36, 37, 38 may be entirely replaced by a different attachment element, fixed to the plates 32, 32', and having any shape, such as a C or a box shape and of a predetermined thickness, operable to be deformed by buckling so as to absorb and dissipate impact energy.

In addition, the shearable couplings may be made so that the respective bolt 36, 37 is sheared. The various couplings may be constituted by pins or rivets. Finally, the rail 10 may have a different cross-section and/or height, and/or number of crests from those indicated above.

Claims

1. A semi-rigid road barrier providing high dissipation of impact energy and attitude correction, in which a metal rail (10) is supported in a substantially vertical orientation by a series of metal uprights (13) fixed along the edge (18) of a road carriageway, at least one of the upright (13) being provided with means of attachment (31, 31') for the rail (10) operable to dissipate at least some the impact energy on the rail (10), characterised in that the attachment means (31, 31') include a spacer member (31, 31') operable to rotate relative to the upright (13) so that, following deformation of the upright (13) towards the outside of the carriageway, the rail (10) maintains a substantially vertical orientation.

2. A barrier according to Claim 1, characterised in that the spacer member (31, 31') is pivoted on the upright (13) and is also connected to it by means (44, 44'; 47, 47') operable to allow the spacer member (31, 31') to rotate to a certain extent relative to the upright (13).

3. A barrier according to Claim 2, characterised in that the means (44, 44'; 47, 47') provided to allow this rotation include a guide element (47, 47') positioned at a certain vertical distance from the fulcrum (43, 43') between the spacer member (31, 31') and the upright (13) and a curved slot (44, 44') engaged with the guide element (47, 47') and concentric with the fulcrum (43, 43').

4. A barrier according to Claim 3, characterised in that the spacer member (31) includes a plate (32) pivoted on the upright (13) so as to project therefrom inwardly of the carriageway, with the slot (44) extending from a vertical line through the fulcrum (43) outwardly of the carriageway.

5. A barrier according to Claim 3 for use as a directional traffic separator, characterised in that the spacer member (31') includes a plate (32') pivoted on the upright (13) and supporting two rails (10) cantilevered thereby towards two different carriageways, the slot (44') extending from a vertical line through the fulcrum (43') in two opposite directions.

6. A barrier according to any one of the preceding Claims, characterised in that the spacer member (31, 31') is connected to the rail (10) by an attachment element (26), with means (36, 37, 38) for dissipating impact energy being mounted between the spacer member (31, 31') and the attachment element (26).

7. A barrier according to Claim 6, characterised in that the energy-dissipating means (36, 37, 38) include at least one coupling (36, 38; 37, 38) operable to break under a predetermined force which is less than the force required to deform the upright (13).

8. A barrier according to Claim 7, characterised in that the attachment element (26) includes a flange (27) for mating with the plate (32, 32') and in that the coupling (36, 38; 37, 38) includes a pin (36, 37) engaged in a hole (33, 34) adjacent a partition (38) adapted to be sheared, the pin (36, 37) and the hole (33, 34) being positioned the one on the plate (32, 32') and the other on the flange (27).

9. A barrier according to Claim 8, characterised in that the hole (33, 34) is adjacent a second hole (41, 42) and separated therefrom by the partition (38), the holes (33, 41; 34, 42) being substantially

semicircular and aligned horizontally.

10. A barrier according to any one of Claims 6 to 9, characterised in that two vertically-spaced shearable couplings (36, 38; 37, 38) are provided between the spacer member (31, 31') and the attachment element (26), the guide element (47) and the pins (36, 37) consisting of connecting bolts with nuts.

11. A barrier according to Claim 10, characterised in that the couplings (36, 38; 37, 38) are equidistant vertically from the fulcrum (43, 43'), one of these couplings (36, 38; 37, 38) being higher than the slot (44, 44').

12. A barrier according to Claim 10 or 11, characterised in that the upright (13) includes a C-shaped section (14) strengthened in correspondence with the spacer member (31, 31') by another section (22) so as to form a box structure (14, 22).

13. A barrier according to Claim 12, characterised in that the spacer member (31, 31') includes a pair of parallel plates (32, 32') pivoted on two opposite walls of the structure (14, 22), means (21, 24) being provided on the structure (14, 22) to allow the plates (32, 32') to slide axially.

14. A barrier according to Claim 13, characterised in that the plates (32, 32') are connected by the couplings (36, 38; 37, 38) to two flanges (27) of a C-shaped element (26), the rail (10) being formed of longitudinally corrugated sheet and fixed to the central portion (28) of the C-shaped element (26).

15. A barrier according to any one of Claims 8 to 14, in which the uprights (13) are also connected together by a wheel-impact element (48) and by a rib (51) which serves as a tie bar following an impact on the rail (10), characterised in that following an impact the energy therefrom is absorbed partly by the shearing of at least one of the couplings (36, 38 and 37, 38), partly by the rotation and translation of the spacer member (31, 31'), partly by the rib (51) and partly by the deformation of the upright (13).

16. A barrier according to Claim 15, characterised in that, following an impact causing inclination of the upright (13), the attitude of the rail (10) is substantially maintained by the rotation of the spacer member (31, 31') on the fulcrum (43) and by the at least partial recovery of the height it had in its original position by the sliding of the spacer member (31, 31') relative to the upright (13).

17. A barrier according to any one of Claims 1 to 5, characterised in that the spacer member (31, 31') is fixed to an integrally-formed attachment element (26) with a C-shaped or box section, of predetermined thickness, this attachment element (26) being crushable so as to absorb and dissipate impact energy.

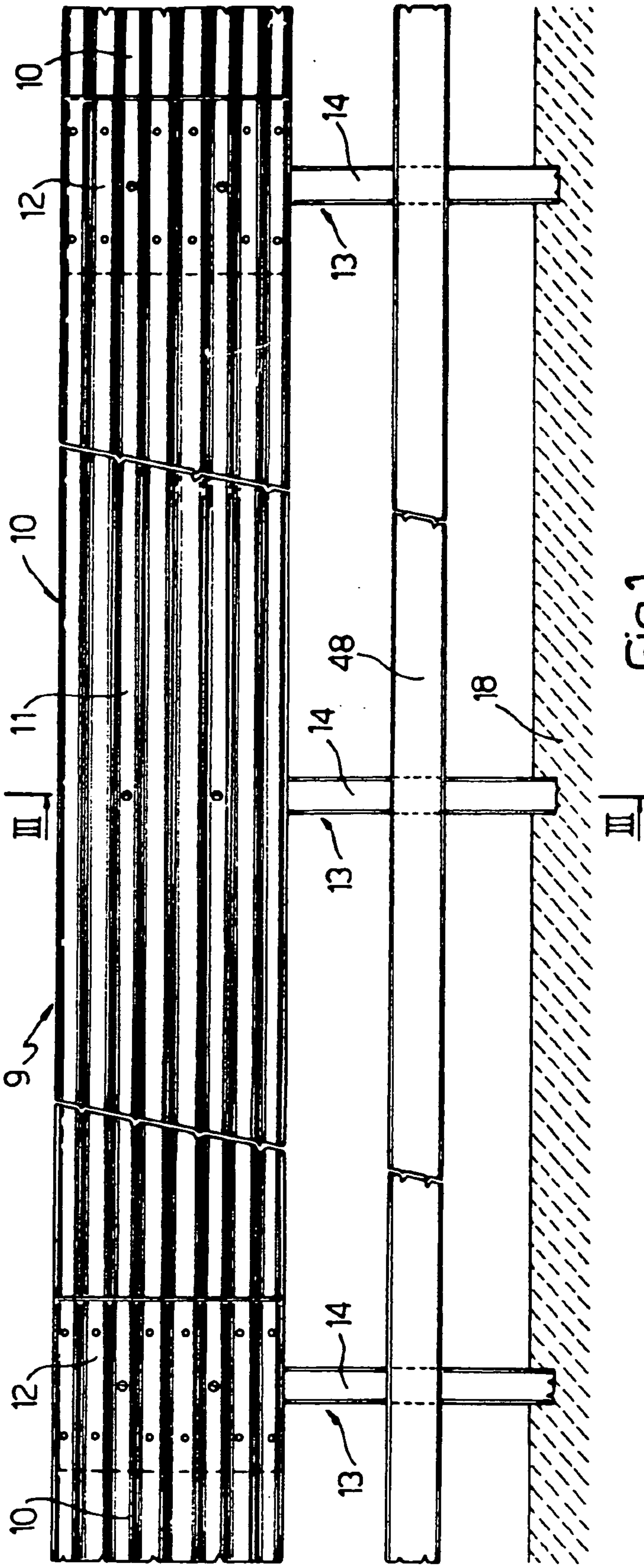

Fig.1

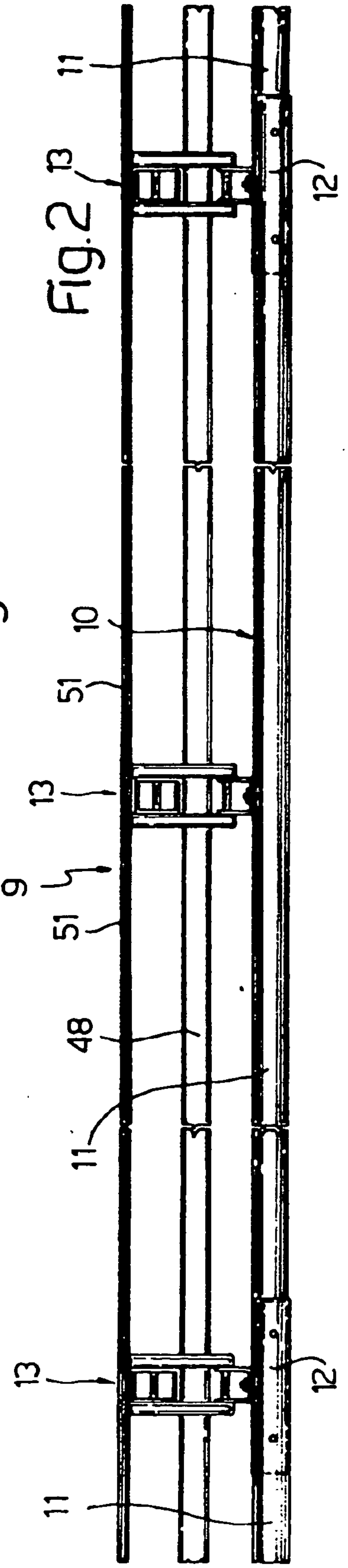

Fig.2

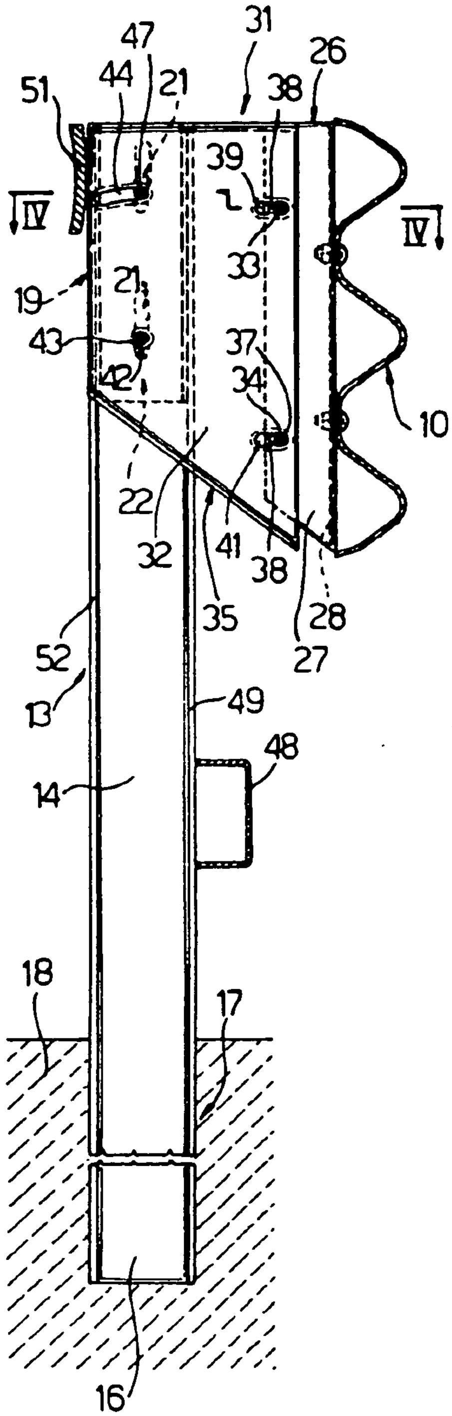

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Fig.3

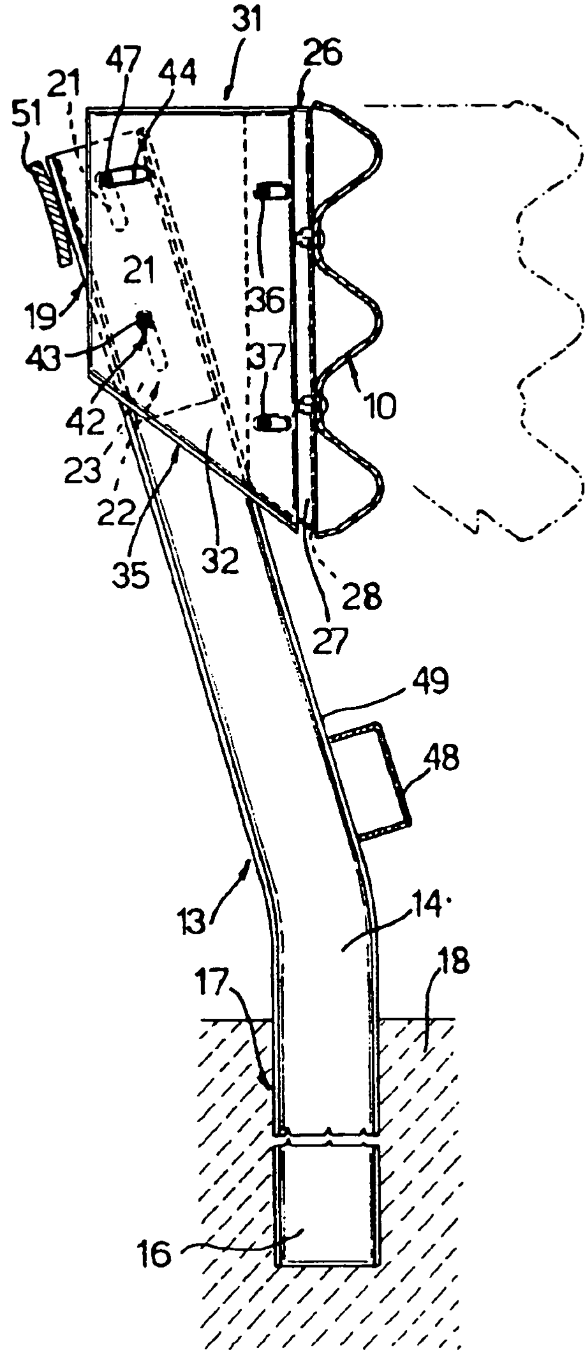

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Fig.6

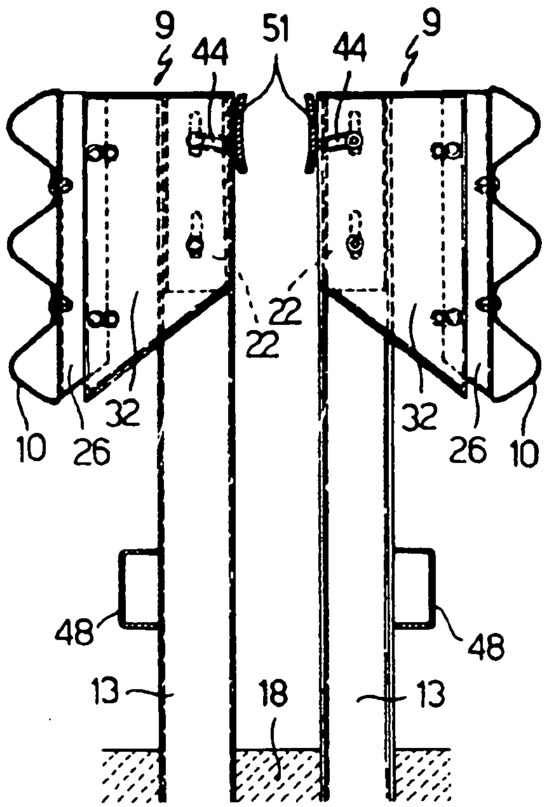


Fig.8

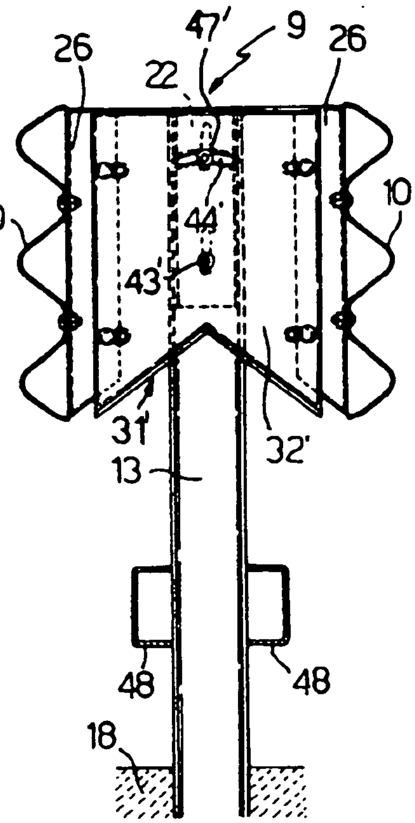
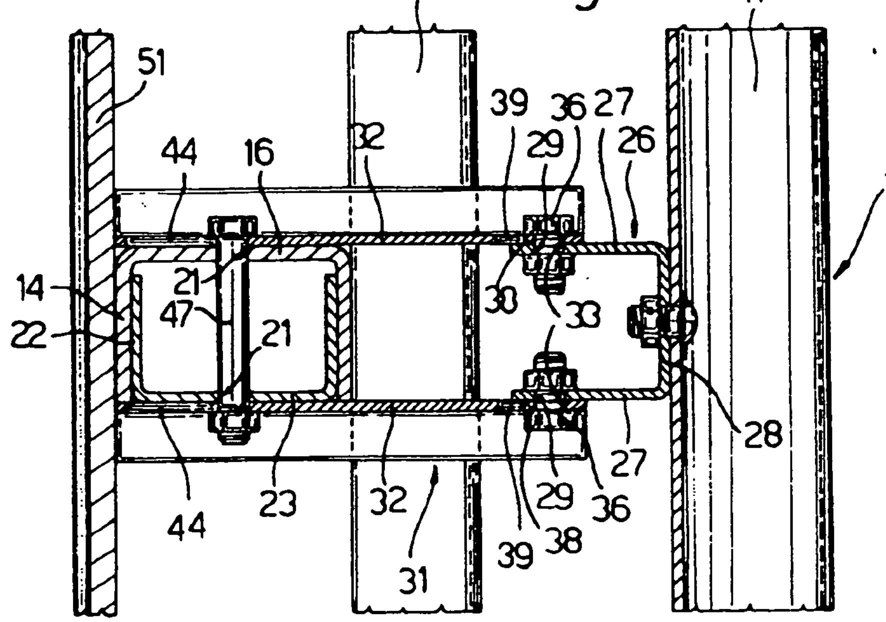


Fig.10

Fig.4



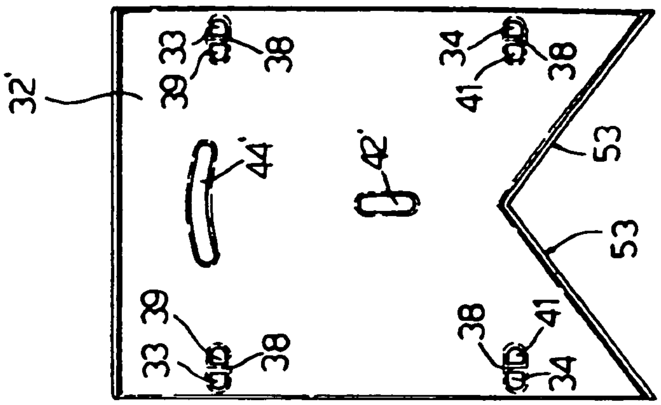

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Fig.11

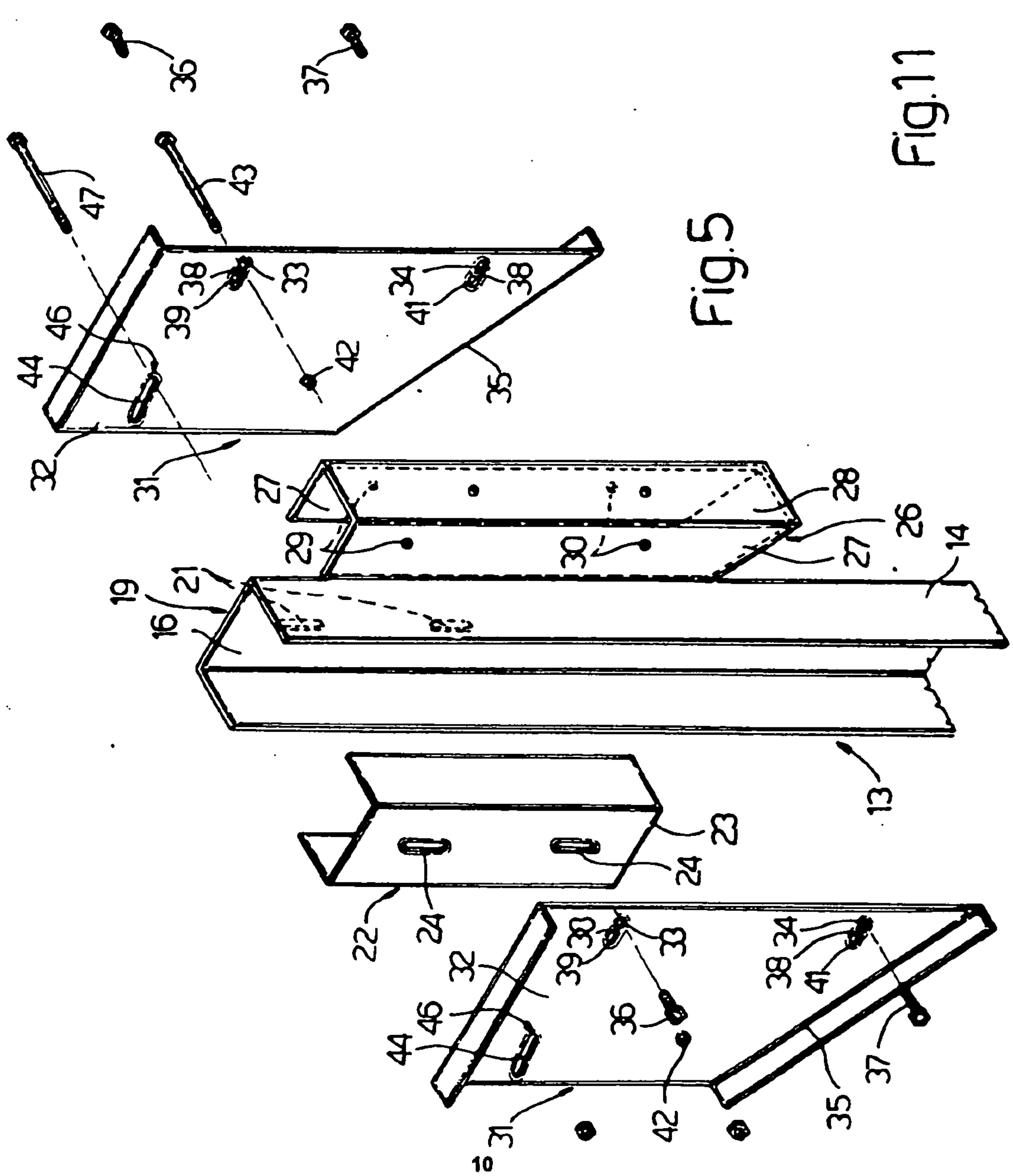
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Fig.5

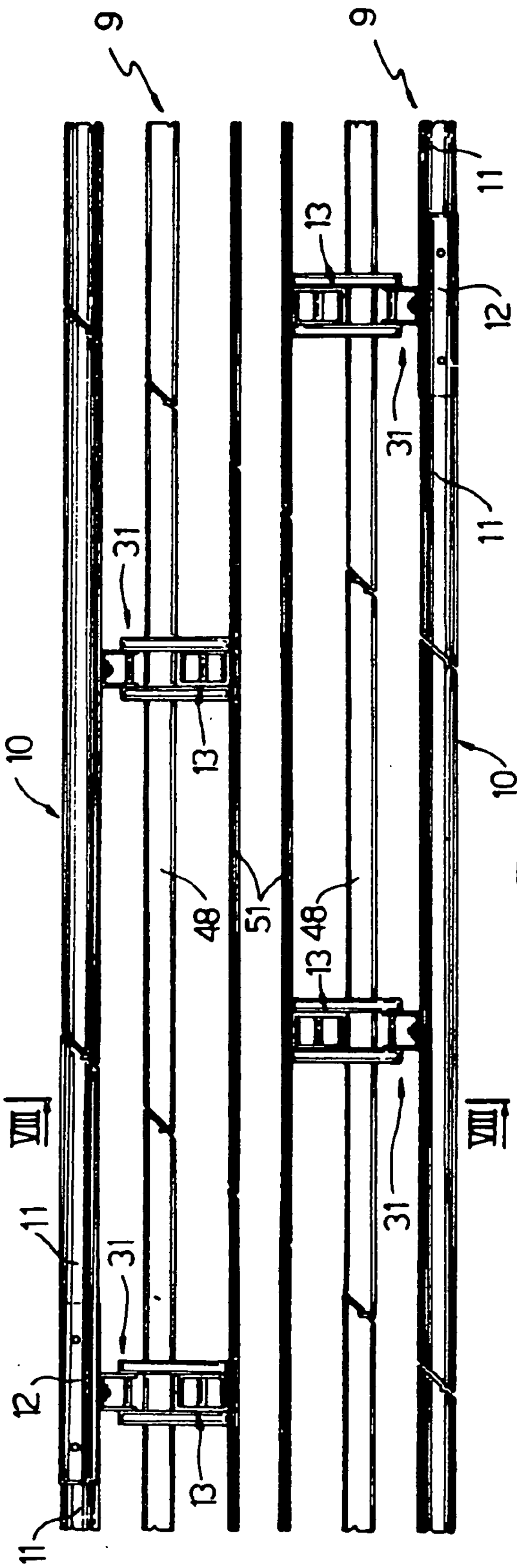
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Fig.7

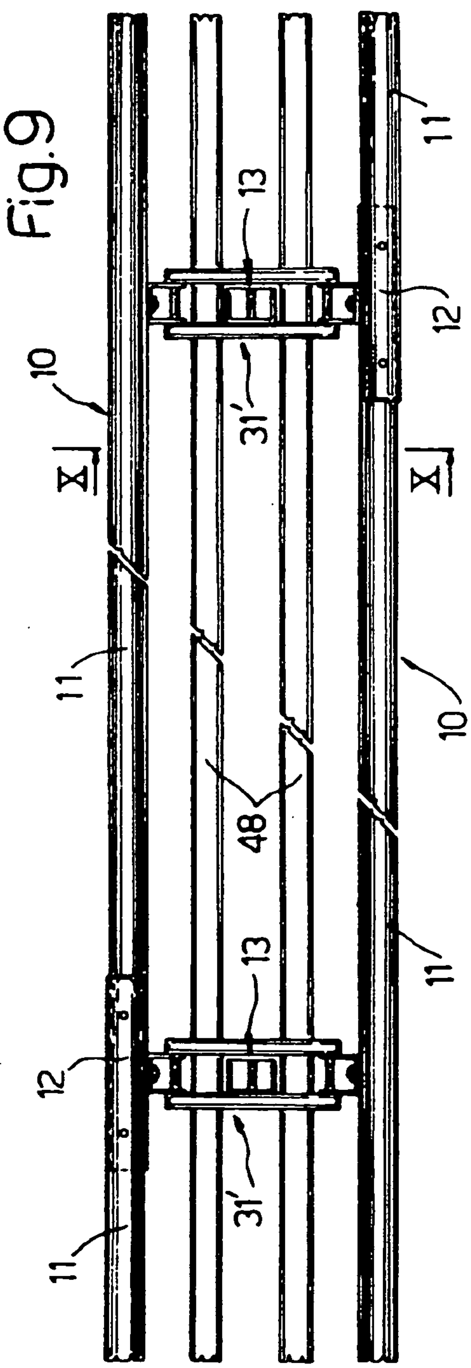
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Fig.9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 10 1729

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 356 686 (METALMECCANICA FRACASSO)	1,2,6-9, 15,17	E01F15/00
Y	* the whole document *	3-5	
A		10,13,14	

Y	DE-A-2 461 942 (ALPIN MONTAN)	3-5	
A	* page 6, line 17 - line 22; figures 1,7 *	1	

A	BE-A-782 308 (A.NEHER MASCHINENFABRIK)	12	
	* figure 1 *		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
E01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 APRIL 1993	VERVEER D.

CATEGORY OF CITED DOCUMENTS

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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